MINING METHODS AND COSTS, BLACK ROCK TUNGSTEN MINE, WAH CHANG MINING CORP., MONO COUNTY, CALIF.

By A. C. Johnson and N. M. Fillip

* * * * * * * * information circular 7945

UNITED STATES DEPARTMENT OF THE INTERIOR
Fred A. Seaton, Secretary

BUREAU OF MINES
Marling J. Ankeny, Director

Generated on 2024-09-22 01:40 GMT / https://hdl.handle.net/2027/osu.32435030643365
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

This publication has been cataloged as follows:

Johnson, Albin Carl, 1897–

Mining methods and costs, Black Rock tungsten mine, Wah Chang Mining Corp., Mono County, Calif., by A. C. Johnson and N. M. Fillip. [Washington] U.S. Dept. of the Interior, Bureau of Mines [1960].

19 p. illus., maps. 26 cm. (U.S. Bureau of Mines. Information 7945)

1. Tungsten mines and mining—California—Mono Co. 2. Wah Chang Mining Corporation. I. Fillip, N. M., joint author. II. Title. (Series)

TN23.U71 no.7945 622.06173

U.S. Dept. of the Interior. Library

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. - Price 45 cents

Generated on 2024-09-22 01:40 GMT / https://hdl.handle.net/2027/osu.32435030643365
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

Digitized by Google

Original from THE OHIO STATE UNIVERSITY

CONTENTS

	Page
Summary	1
Introduction	2
Acknowledgments	2
History	2
Geologic summary	5
Origin of the tungsten ores	5
Structure	6
Minerals	6
Prospecting and exploration	6
Sampling and estimation of tonnage and values	7
Methods of development and mining	7
Mine workings	7
Development details	8
Stoping	12
Underground transportation	13
Auxiliary operations	14
Production	16
Ventilation	16
Mine drainage	17
Fire prevention	17
Safety methods, first-aid training, and organization	17
Summary of costs	18

ILLUSTRATIONS

Fig.		Page
1.	Location map, Black Rock mine	3
2.	Aerial view of principal mine workings, Black Rock mine	4
3.	Composite map, Black Rock mine	9
4.	Black Rock mine section 2100 N	10
5.	Black Rock mine section 2500 N	11
6.	Aerial view, Black Rock mine and mill	15

Generated on 2024-09-22 01:32 GMT / https://hdl.handle.net/2027/osu.32435030643365
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

MINING METHODS AND COSTS, BLACK ROCK TUNGSTEN MINE, WAH CHANG MINING CORP., MONO COUNTY, CALIF.[1]

by

A. C. Johnson[2] and N. M. Fillip[3]

SUMMARY

This report is one of a series being prepared by the Bureau of Mines on exploration, development, mining methods, and costs at various mines in the United States. It describes operations at the Black Rock mine, Wah Chang Mining Corp., Mono County, Calif. The purpose of these reports is to promote development and conservation of our mineral resources by disseminating technologic information on mining methods, practices, and costs.

The Black Rock tungsten mine of the Wah Chang Mining Corp. is 33 miles north of Bishop, Calif., in the Benton Range, Mono County, Calif. The property was acquired in August 1950 and a well-planned program of exploration, development, and exploitation resulted in a good production record with low costs. Operations were halted in July 1957, about 6 months after suspension of the tungsten purchase program by the Federal Government.

The mine is developed by five levels (the 6500, 6600, 6700, 6800, and 6900) interconnected by raises, manways, and stopes. The best surface exposures were exploited by three large opencuts--the Glory Hole, Senior, and the No. 9 pits. No rigid system of mining was used underground owing to the sporadic nature of the mineralization. The mining methods were determined by the general attitude, size, and shape of the ore bodies. All mucking was done by air-operated shovels. The material from stopes, including intermediate drifts and raises was scraped directly into cars or into drawpoints for loading by air-operated mucking machines.

Mining and development costs averaged $7.98 per ton of ore from January 1 to June 30, 1957, and 7.62 tons per man-shift was produced during this period.

1/ Work on manuscript completed January 1959.

2/ Supervising mining engineer, Bureau of Mines, Region II, Reno, Nev.

3/ Mine superintendent, Wah Chang Mining Corp., Benton Division, Mono County, Calif.

Generated on 2024-09-22 01:28 GMT / https://hdl.handle.net/2027/osu.32435030643365
Public Domain, Google-digitized / http://www.hathitrust.org/access use#pd-google

Digitized by Google

Original from THE OHIO STATE UNIVERSITY

INTRODUCTION

The 32 claims of the Black Rock mine are located in the Benton Range, secs. 12, 14, and 23, T. 3 S., R. 31 E., Mount Diablo meridian. Figure 1 shows highways leading to the mine.

The principal mine workings and installations were at an elevation of 6,500 to 7,200 feet. Figure 2 is a view of the terrain. The climate was mild, with warm summers and cool winters. There was little rainfall, and the light snowfalls never seriously curtailed mining operations.

The Black Rock group lies in the Indian mining district. Although a small production of lead and silver ore had been recorded from this district, no mine of major importance had been operated before the tungsten mining operations of the Wah Chang Mining Corp.

A mine-to-market access road was completed in November 1952. This road originated about 25 miles north of Bishop on U.S. Highway 6 and extended westerly to the mine and mill. No realinement or major road work was required, as construction involved only macadam surfacing of an existing dirt road.

Communications with the main office in Bishop were by radio-telephone.

ACKNOWLEDGMENTS

The authors thank J. J. Strutzel, Jr., general manager, for permission to use data presented in this report. Special acknowledgment is made to Robert S. Holmes, general superintendent, Black Rock mine, for his suggestions and aid in preparing the report.

HISTORY

The first claims at Black Rock were located in 1916 by John Unthank of Bishop, Calif., who later allowed the claims to return to the public domain. The claims were relocated in the spring of 1927 by A. E. Beauregard of Bishop, Calif., who erected the first mill on the property the same year. The mill had a rated capacity of 1 ton per hour, and it was operated intermittently until the fall of 1930.

The property was idle until 1936, when Cecil Smith leased the ground, formed the Tungsten Corporation of California, and erected a 135-ton mill. During the period 1937-41, about 115,000 tons of ore was milled. The mill was a straight gravity plant, and losses were high owing to the extreme fineness of the scheelite mineral. Reported recovery averaged 46 percent. Exploration was conducted on the property by the Federal Bureau of Mines during 1940-41.4/

4/ Dupuy, Leon W., Black Rock Tungsten Deposit, Mono County, Calif.: Bureau of Mines Rept. of Investigations 4210, 1948, 6 pp.

Generated on 2024-09-22 01:31 GMT / https://hdl.handle.net/2027/osu.32435030643365
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

FIGURE 1. - Location Map, Black Rock Mine.

Generated on 2024-09-22 01:29 GMT / https://hdl.handle.net/2027/osu.32435030643365
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

FIGURE 2. - Aerial View of Principal Mine Workings, Black Rock Mine: (1) No. 9 pit, (2) senior pit, (3) glory hole, (4) 6700 level. *(Courtesy, Robert Symons, Symons Flying Service, Bishop, Calif.)*

Generated on 2024-09-22 01:30 GMT / https://hdl.handle.net/2027/osu.32435030643365
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

In 1941 the Tungsten Corporation of California ceased operations, and A. E. Beauregard resumed operation of the mine. He reactivated his original mill and reworked the tailings, principally from the former operation.

In 1947, A. E. Beauregard leased the mine to the Tungstar Corporation. Although this corporation did considerable development work, little ore was produced. In 1948-49 the company mined and milled 2,000 tons of ore and hauled it to the Pine Creek mill on the Tungstar Corporation, 50 miles southwest of the Black Rock mine.

No further production was reported until the mine was acquired in August 1950 by the Wah Chang Mining Corp. (then the Black Rock Mining Corp.).

GEOLOGIC SUMMARY[5/]

The geology of the district has been described by Dwight M. Lemmon as follows:

> The east slope of the southern part of the Benton Range consists mainly of folded and faulted metamorphic rocks and of granite intruded into them. All these rocks are cut by dikes of aplite, rhyolite, and diabase. The metamorphic rocks are dominantly schist and quartzite associated with less abundant limestone and tactite. The tactite largely composed of garnet and epidote, was formed by the metamorphism of limestone. Tertiary and quaternary volcanic rocks consisting largely of rhyolite tuff and basalt flows now surround the range, and remnants of tuff are found within the range itself.
>
> Although granite constitutes most of the northern part of the range, the metamorphic rocks predominate at the south end, and here the granite, which probably underlies the entire area, crops out only in isolated patches. The metamorphic rocks can be roughly divided into three units: (1) a lower schist and quartzite, (2) an intermediate limestone, now largely metamorphosed to tactite, which contains the tungsten ore, and (3) an upper schist and quartzite. The thickness of none of these units is definitely known, but the limestone appears to be at least 700 feet thick at the Black Rock Mine.

Origin of the Tungsten Ores

According to Lemmon:

> The tactite bodies were formed by metamorphism of the limestone during intrusion of the granite. Probably the scheelite itself was introduced at a late stage in the process and the ore bodies were localized primarily by the physical characteristics of certain beds, especially porosity and fractures. The localization of ore shoots was probably determined in part by minor cross fractures.

5/ Lemmon, Dwight M., Tungsten Deposits of the Benton Range, Mano County, Calif.: Geol. Survey Bull. 922-S, 1941, pp. 581-593.

534958 O - 60 - 2

Generated on 2024-09-22 01:32 GMT / https://hdl.handle.net/2027/osu.32435030643365
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Most of the tactite is barren. The ore bodies, which constitute an insignificant part of the tactite zones, do not form prominent outcrops, but several barren tactite beds 20 to 100 feet thick project above the detritus-covered slopes. The intensity of metamorphism varies along the strike of some of these barren beds, possibly because of their distance from the underlying granitic intrusive.

Structure

The mine is located east of a north-trending granitic intrusion, cut by north-trending aplite diabasic and quartz dikes. The general structure at the mine is characterized by a northerly plunging asymetric anticline. The dip toward the east is steeper than the dip toward the west. The anticlinal structure is modified by north-south and east-west faults and secondary folds. The western limb dips approximately 70° to an unknown depth, whereas the eastern limb dips 45° to 80°. Faults parallel to the bedding are common to both limbs, and north-south and east-west faults are frequent along the crest of the anticline. The ore is found in tactite in favorable zones, generally paralleling the bedding. The beds had been warped, with accompanying thinning on the flanks and thickening along the crest. The ore favored the crest of the anticline and was found in other local flattening of the favorable zones.

The best surface showings were along the crest and in the west limb of the anticline. As previously stated, they were exploited by three large open-cuts--the Glory Hole, Senior, and No. 9 pits. The ore in these pits was approximately along the stratigraphic horizon of the underground ore bodies. Tactite exposed between the pits contained little or no scheelite. (See fig. 2.)

Minerals[6/]

The following listing is from Lemmon's description of the associated minerals:

> The ore at the Black Rock mine is a scheelite-bearing tactite, which consists, in the main, of the same silicate minerals as the adjoining barren tactite. The chief minerals in the ore, listed in order of abundance, are garnet, amphibole, diopside, calcite, epidote, quartz, and scheelite. In addition there are variable amounts of sulfides, chlorite, and probably nontronite.
>
> Scheelite, the only ore mineral, forms crystals disseminated through the tactite. A few of the crystals are as much as half an inch in diameter, but most of them are microscopic.

PROSPECTING AND EXPLORATION

Diamond drilling was used to prospect and delineate favorable zones. Occasionally, a hole was drilled within the ore to another level to provide

---

6/ Work cited in footnote 5.

Generated on 2024-09-22 01:31 GMT / https://hdl.handle.net/2027/osu.32435030643365
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

ventilation and line for a future raise. The holes were usually collared with AX bits (1-1/2-inch core). If necessary, they were cased, and the bit size was reduced to EX (7/8-inch).

Where short holes 70 feet or less were sufficient to determine the existence of ore on or above the level and geologic detail was of secondary importance, sectional-steel and jackleg or Leyner drills were used.

No distinction was made between exploration headings and development headings because of the discontinuous nature of the ore. Every development heading was considered exploration, regardless of whether it was in stope preparation or merely following a geologically favorable horizon.

SAMPLING AND ESTIMATION OF TONNAGE AND VALUES

Information gained by diamond drilling, drifting, crosscutting, raising, and long-hole drilling was combined to make ore estimates. Diamond drilling and long-hole drilling also served as guides for development headings.

During normal production, the Mineralight was used to delineate the areas to be mined in the stopes. Grab samples of muck were taken for analyses, also grab samples of the rock from all development working places. Samples were taken from each car from each producing stope. In addition to sampling, all mine bosses carried Mineralights to make on-the-spot determinations of broken material by lamping muck piles. The "lamping" determined whether the broken material was to be milled or classified as waste. Considerable skill was developed with experience, so that a reliable separation of the ore and waste could be made using the Mineralight.

METHODS OF DEVELOPMENT AND MINING

Mine Workings

A stratigraphic column of the mine from top to bottom shows: (1) Hornfels capping rock; (2) approximately 150 feet of silicated limestone containing some tactite bands parallel with the bedding; (3) Nos. 5 and 6 ore zones, totaling about 55 feet thick; (4) a block of silicated limestone, averaging 37 feet thick; (5) another ore zone about 8 feet thick; and (6) the footwall of marble, silicated limestone, and tactite, containing ore in the center of the anticline.

The ore appears high in the column in No. 5 zone near the granite. The footwall of this zone is tactite containing a large quantity of pyrrhotite. No. 7 zone was approximately 8 feet thick and was usually tactite, although unreplaced marble was found in parts of the zone. The hanging wall was bedded silicated limestone, which was also the footwall of No. 6 zone. The footwall of No. 7 zone was a mxiture of tactite, marble, and silicated limestone. No. 8 zone was the zone in the center of the anticline that had been extensively folded and faulted and was stratigraphically below No. 7 zone. The ore body in No. 8 zone was irregular in shape, and the ore values were spotty. The thickness of the ore bodies ranged from 6 to 40 feet and their dips from 10°

Generated on 2024-09-22 01:35 GMT / https://hdl.handle.net/2027/osu.32435030643365
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

to 70°. Owing to their complex nature, it was impossible to block out ore for any definite system of mining, and the ore was usually mined as it was being developed.

The underground mine comprised five levels at approximately 100-foot vertical intervals. Each level was named by its approximate elevation above sea level--6500, 6600, 6700, 6800, 6900. (See fig. 3.) All levels were interconnected by raises, manways, and stopes resulting in ample natural ventilation. The 6600 level was the only one without an adit to the surface. This level was serviced by a winze from the 6700 level.

As already indicated, the ore occurred as bodies or shoots under favorable structural and mineralogical conditions and within favorable zones. (See figs. 4 and 5.) These favorable conditions could not be determined accurately enough to predict the location of ore bodies with any certainty. Therefore, development drifts were driven along one wall of a zone, either the hanging or foot wall, and test holes were drilled to the opposite wall as the drift was advanced. Inclined diamond-drill holes were drilled to explore the zone between levels. In this manner, the zones were explored extensively in every dimension.

Development Details

All development drifts and crosscuts on the sill were driven a standard 6- by 7-foot size except on the 6500 level (main haulage drift), where the size was 8 by 9 feet. Where ground conditions required the use of timber, the drifts were oversize to allow for the timber yet maintain adequate room in the drift. Raises for normal development were driven 6 by 6 feet. Little timber was required for ground support in drifts or raises, as the ground was generally good throughout the mine.

Drifting and crosscutting were done exclusively with jackleg-type drilling machines and 1-3/8-inch integral chisel bit steel. Because of limited shop facilities, it was more efficient to use integral bit steel than detachable bits and threaded steel; however, jacklegs and Leyners with sectional steel and 1-3/4-inch detachable tungsten carbide bits were used for the limited long-hole drilling program. All raising above 45° was done with stopers and below 45° with jacklegs.

The pattern of a round and the number of holes in a round varied with the nature of the ground and the experience of the miner. The number of holes varied from 16 to 32, depending upon the hardness of the ground. The type of cut used was determined by ground conditions and the miner's preference. The most common cut used was the three- to five-hole burn. Hercules EPX 160, 1- by 8-inch dynamite was used, and most rounds were primed with black fuse primers and bunch-blasted. Experimental blasting with igniter cord and connectors proved satisfactory, especially from the standpoint of safety. All mucking on the sill was done with air-operated rocker shovels. Broken material in stopes, intermediate drifts, and raises was scraped directly into cars or drawpoints for loading by mucking machines.

Generated on 2024-09-22 01:36 GMT / https://hdl.handle.net/2027/osu.32435030643365
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-22 01:40 GMT / https://hdl.handle.net/2027/osu.32435030643365
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

FIGURE 3. - Composite Map, Black Rock Mine.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

FIGURE 4. - Black Rock Mine Section 2100 N.

Generated on 2024-09-22 01:32 GMT / https://hdl.handle.net/2027/osu.32435030643365
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

FIGURE 5. - Black Rock Mine Section 2500 N.

Generated on 2024-09-22 01:35 GMT / https://hdl.handle.net/2027/osu.32435036430365
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

The normal cycle of operation was to muck, drill, and blast, all blasting being done at the end of the shift. However, where the ground was soft and more than one cycle was possible in an 8-hour shift, the ventilation was such that onshift blasting could be done without interfering with other operations.

Stoping

No standard system of stoping was used. The method was determined by the general attitude, size, and shape of the ore body to be mined. The system had to be very flexible to allow for unforseen faulting, low-grade areas, pinching, or changes of attitude of the ore shoot.

For thin, flat ore shoots about 6 feet wide and dipping 10° to 20°, scraping was necessary. If the ore body was being mined from a drift, parallel headings were advanced up dip on convenient centers (30 to 50 feet) at right angles to the strike. If the headings encountered large blocks of waste, they were left as pillars. The ore blocks bounded by these main headings were mined by running diagonal headings through them, leaving diamond-shaped pillars for ground support. The size of the pillars were governed by the strength of the hanging wall in the area. Some ore zones had bedding-plane faults parallel to the hanging-wall limestone. These areas required larger pillars than those with a firm tactite hanging wall. Slusher ramps were installed in the haulage drift, and the ore was scraped directly into cars.

When these thin ore bodies had dips of more than 30°, they were developed by raises from the sill. The mining system was virtually the same; however, the ore was scraped into the raises and loaded into cars by chutes or mucking machines.

Thick ore shoots were prepared by driving raises on 25-foot centers or less. The raises were then connected, leaving a thin pillar over the back of the dirft. At least two raises, preferably at opposite ends of the block, were left open to serve as manways and insure ventilation. Control timbers were installed in the drawpoint raises, and stoping was advanced up dip in a modified shrinkage stope. As mining progressed, ore was mucked from the drawpoint raises with mucking machines. Pillars were established, and the back was made safe by roof bolting in the hanging wall if necessary.

Mining up dip was advanced at an angle slightly steeper than 45°--the angle of repose of the broken ore. As a result, ore was left in place on the footwall of the stope, and the advance was finally terminated at the end of the ore shoot. When this point was reached, the broken ore was drawn out, a slusher installed, and mining begun again along the footwall. Most of the remaining production from the stope was then slushed to the drawpoints. With this system of mining, it was possible to mine as much as 50 percent of a flat-dipping block without slushing.

Ore bodies in oxidized and badly faulted zones were mined by a combination of the two systems just described.

Generated on 2024-09-22 01:28 GMT / https://hdl.handle.net/2027/osu.32435030643365
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Small raises were begun on about 20-foot centers and advanced up dip at an inclination of approximately 45°. Diagonal advances were made through the resulting blocks, leaving fairly large pillars. Each round was mucked out as it was blasted, to keep the raises open for maximum ventilation and allow a choice of access to any face in the stope. Dangerous areas were bypassed until they could be made safe.

When mining reached the hanging wall of the ore, a slusher was installed and any ore left on the footwall was mined. As the footwall was reached, the pillars were progressively thinned out and reduced in size, working from the lowest section of the stope to the top. This method permitted removal of more than 80 percent of the ore without timbering.

Before a raise or ore pass was driven between levels, a 1-7/8-inch diamond-drill hole was drilled from the level above at the desired location. A raise was then driven up the hole. A device that could be used either to exhaust powder fumes or blow fresh air down to the face of the raise, was installed at the collar of the drill hole. The apparent added cost per foot of raise advance was more than offset by the saving in engineering cost and by the increased rate of advance.

Underground Transportation

Underground tramming was done by hand on the 6900 and 6800 levels, by 1-1/2-ton Mancha locomotives on the 6700 and 6600 levels and by a 6-ton Mancha diesel locomotive on the 6500 level.

The ore cars used on the upper levels were 20-cubic-foot Nevada City side-dump cars, and cars used on the 6500 level were 5-ton Granby-type side-dump cars. The track gage on the upper four levels was 18 inches and on the 6500 level 24 inches.

The mine production was hauled to outside dumps on all levels except the 6800 and 6600 levels. On the 6800 level, approximately 80 to 90 percent of the broken material was hand-trammed to the 6800-level grizzly and ore passes. This material was then trammed from the 6700 level to the outside dumps. The remaining material (10 to 20 percent) on the 6800 level was hand-trammed to the outside dump. On the 6600 level, all material was motor-trammed to the 6600-level ore-or-waste pass, then trammed on the 6500 level to the outside dump.

The material from the 6800-level ore pass and from the 6600-level ore-or-waste passes was pulled through standard-design, steel-lined timber chutes with air-operated steel arc gates and wooden stopboards above the gates. The grizzly rails at the top of these ore-or-waste passes were placed on 16-inch centers. Grizzly rails were 3-inch-diameter rod-mill rods.

The only permanent hoisting equipment used was at the winze between the 6600 and 6700 levels, where a P2000 model, air-operated, Chicago pneumatic utility hoist was used for servicing the 6600 level. Additional Ingersoll-Rand utility hoists were used where possible for servicing stopes.

Generated on 2024-09-22 01:37 GMT / https://hdl.handle.net/2027/osu.32435030643365
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Auxiliary Operations

The mine shops and compressors were centrally located at the 6700-level yard area. All welding, blacksmithing, steel sharpening, repairs, and maintenance, except jobs requiring machine-shop facilities, were done at the mine.

Records were kept of performance and repairs of the rock drills, mucking machines, and slushers. A rigid lubrication schedule was followed to insure the longest possible life for each piece of equipment. The manufacturer's lubrication guides were modified to suit the particular conditions at this operation and to standardize lubricants required. Where possible, multi-purpose greases were used.

Many items that normally would be purchased, such as slusher eyebolts and pins and mucking-machine buckets, were fabricated at the mine shop. These items were made at a lower cost and sometimes were more suitable than the manufacturer's product.

The compressor plant consisted of two electric Atlas diesel AR5 compressors with a rated capacity of 1,000 c.f.m. each; one electric Atlas diesel AR3 compressor with a rated capacity of 570 c.f.m.; and two Ingersoll-Rand gyra-flow (portable) compressors with a rated capacity of 600 c.f.m.

Surface ore haulage from the outside dumps to the mill was done by a contractor using an Allis-Chalmers HD-9 skip loader to load into trucks having a capacity of 15 tons. The average round trip between the various dumps and the mill was 2 miles (See fig. 6.)

Several small wells were located on or near the property. At one time, these wells supplied all the water needed for operating the mill and mine. However, increased production created the need for a larger volume of water. A new well was drilled in an area of alternate layers of water-bearing alluvium material and pumice bounded by large faults that formed a vast structural trap. The well was drilled 14 inches in diameter and 330 feet deep; at this depth granite bedrock was encountered. The hole was cased with 10-inch perforated pipe.

The well pump was a 30-hp., 6-inch, six-stage, deep-well turbine-type pump with a capacity of 390 g.p.m. at an average pumping depth of 110 feet.

Two booster pumps were installed in parallel; each was a two-stage, 3,600-r.p.m. centrifugal pump. Pump 1 was a 125-hp., 5-inch pump that could handle 270 g.p.m., and pump 2 was a 75-hp., 3-inch pump that pumped 144 g.p.m. against a static head of approximately 1,100 feet. A 6-inch spiral welded line, approximately 3-1/2 miles long, supplied the mill storage tanks.

Electrical power for the pumps was transmitted from the mill substation through a 3-1/2-mile line at 4,160 volts, and transformers at the well reduced the voltage to 440 volts. All pumping was automatically controlled at the mill. The operation consumed 330,000 gallons of water a day.

Generated on 2024-09-22 01:39 GMT / https://hdl.handle.net/2027/osu.32435030643365
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-22 01:33 GMT / https://hdl.handle.net/2027/osu.32435030643365
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

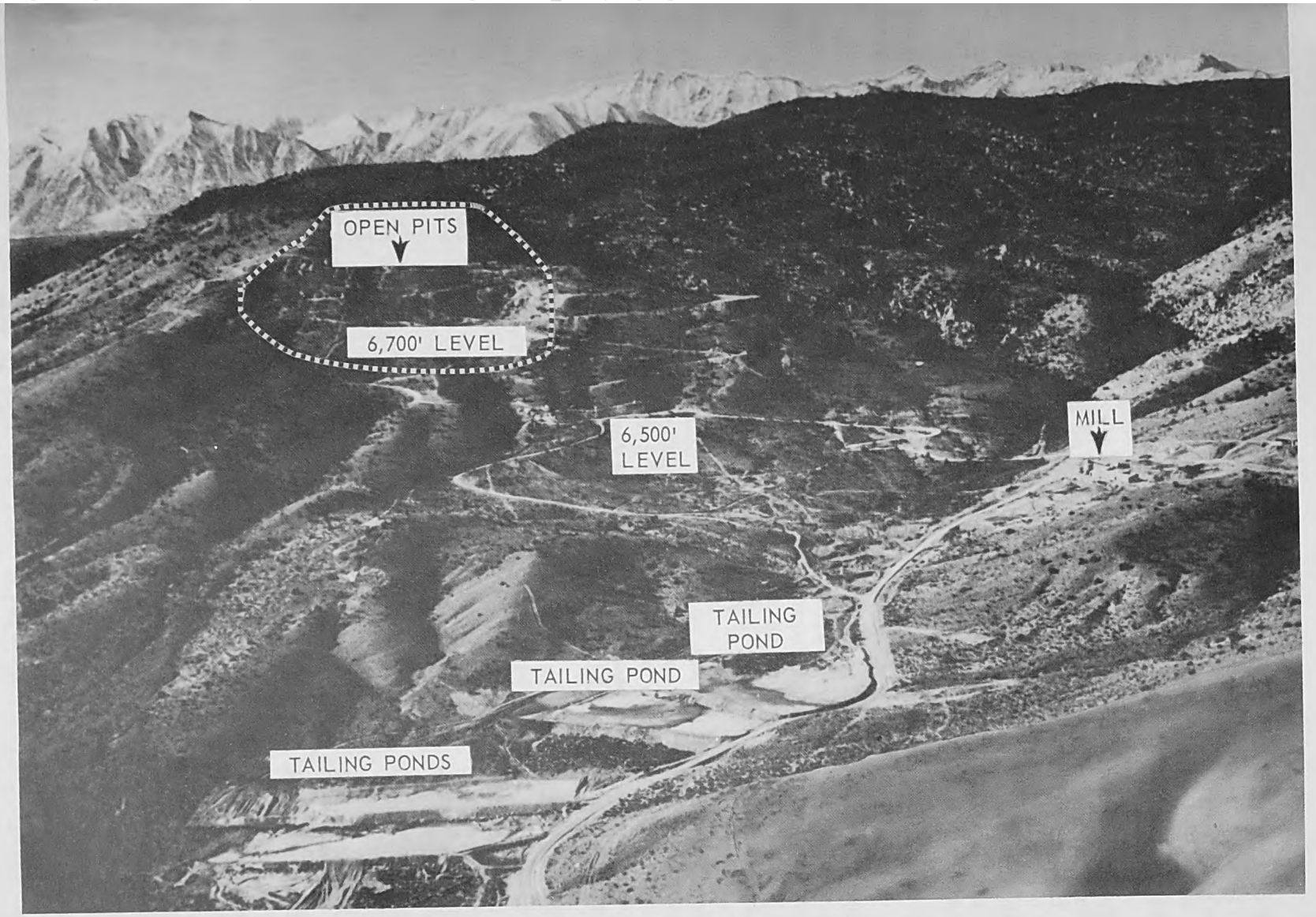

FIGURE 6. - Aerial View of Black Rock Mine and Mill:
(1) Open pits, (2) 6700 level, (3) 6500 level, (4) mill, (5) tailing ponds.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Electrical power was purchased from the Department of Water and Power of the City of Los Angeles. It was brought in from one of the generating plants on the Owens River. The powerline was approximately 12 miles long and was owned by the company. Before the line was constructed, power for the operation was produced at the mill by diesel-driven generators.

Power was received at 34,500 volts and stepped down to 4,160 volts at the mill substation for transmission to the mine or well, where it was further reduced to 440 volts.

Power consumption per month was 500,000 kw.-hr. at a cost of about 7 mills per kw.-hr. Kilowatt-hours were based on peak-load requirement of approximately 1,000 kw.

PRODUCTION

The mine was operated on a 5-day week for two 8-hour shifts a day. The crew comprised 25 men underground and 3 mechanics, supervised by a mine superintendent, a general mine foreman, and a foreman and shift boss on each shift. In addition to the regular shift crew in the shop, a compressor man and a machine mechanic worked the day shift.

Monthly production was nearly 12,500 tons, averaging 0.50 percent WO_3. Approximately 90 percent of the working places and all of the tramming were on a bonus system, which was developed to fit the particular mining methods. The ore-to-waste ratio was 4.5 to 1. However, all waste was not trammed to the surface; where possible, it was gobbed in old working places.

In Nos. 5 and 6 zones, where the ground was good, almost all of the ore was extracted. Where mining was done in oxidized and severely faulted areas, extraction depended upon the condition of the ground. Mining had to be stopped where faulting and oxidation were severe enough to cause caving; these conditions were found mostly on the upper level.

In No. 7 zone a bedding-plane fault ran parallel with the limestone hanging wall, and large pillars were required to hold the back during regular stoping operations. These pillars were reduced when retreating from the stope, so that 70 to 80 percent of the ore was extracted. Dilution in this area resulted from sloughing of the faulted area along the hanging wall.

Production per contract man-shift averaged 17 tons and wages $32. Man-shifts for the period Jan. 1, to June 30, 1957, totaled 9,373 (including shopmen, supervisors, and engineers); production per man-shift averaged 7.62 tons.

VENTILATION

Excellent natural ventilation of the mine was provided by the numerous levels and raises that hole through to the surface between the 6500 and 7100 levels. The only mine ventilation problems were in dead-end drifts, raises, and stopes and at the 6500 level. Hence, little mechanical mine ventilation was necessary.

Generated on 2024-09-22 01:34 GMT / https://hdl.handle.net/2027/osu.32435030643365
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

In dead-end drifts, raises, and stopes, artificial ventilation supplemented existing ventilation. Coppus air-driven Model SP250 and SP300 Vano blowers and 12-inch Bemis Bros. flexipipe were used for this purpose. On the 6500 level, a 10-hp. Joy Axivane Model FS2135 electric blower, mounted at the 6500 portal, was used to comply with State requirements on underground ventilation where diesel trammers are used.

A wooden bulkhead and door were located about 50 feet inside the 6500 portal, and the fan-blown air entered the level through the bulkhead in a 16-inch galvanized pipe. The door opening was controlled to regulate the air entering or exhausting on the level. Doors and bulkheads were also installed throughout the mine to control the flow of air and provide maximum ventilation in active working places.

On the 6500 level, daily tests were made with colorimetric CO detector to test CO content of the diesel exhaust. A record was kept of these readings in the mine office.

MINE DRAINAGE

In the mine area, little water found its way underground. Consequently, the only waterflow in the mine came from water introduced for drilling. The water presented no drainage problems.

FIRE PREVENTION

The surface firefighting equipment consisted of regular fire-hydrant and fire-hose installations in the centrally located mine shop area and similar installations at the mine engineering office and mine changehouse. In addition, CO_2 dry chemical and foam fire extinguishers were placed inside the shops, warehouse, lamp house, compressor building, and other buildings.

Standard fire-alarm warning instructions were posted at either the mine shop or mine engineering office areas. A stench-bomb warning system, manufactured by the Reed Engineering Co., Los Angeles, Calif., was used for clearing the underground crew from the mine in case of fire on the surface or other emergency. A commercial stench bomb was connected to the mine air line and released into the line when needed. Drills were conducted, and warnings released into the line proved that this method was very effective; the crew was cleared from the mine within 2 minutes.

No underground fire rescue training was given at the mine, as little timber was used and the underground fire hazard was slight. The surface firefighting crew comprised the mine-shop crew, who were centrally located to the plant and available at all times. All surface buildings had sprinkler systems.

SAFETY METHODS, FIRST-AID TRAINING, AND ORGANIZATION

The safety program at the mine was administered by the safety engineer, and standard safety practices were enforced to conform with the State Industrial Safety Board requirements. All supervisors and engineers worked under

Generated on 2024-09-22 01:38 GMT / https://hdl.handle.net/2027/osu.32435030643365
Public Domain, Google-digitized / http://www.hathitrust.org/access use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

the direction of the safety engineer to insure compliance with the safety requirements.

An accident-prevention program was followed.

In addition to daily safety supervision by mine bosses and engineers, monthly safety inspection tours of the entire mine were made by a joint company-union safety committee. At meetings held in conjunction with each inspection, recommendations by the committee were submitted for action. Measures taken since the previous inspection were discussed and accidents of the previous month reviewed. Recommendations were made for preventing similar accidents in the future. Except for the safety engineer, the safety committee was composed of different men each month. This arrangement encouraged greater interest and safety consciousness among the men, as it made them directly concerned with inspection and enforcement.

The Bureau of Mines conducted first-aid courses annually. Attendance at the courses was voluntary. Interest and attendance were very good.

Stretchers and first-aid stations were maintained in the lunchroom on each level, and an ambulance with first-aid equipment and oxygen was maintained at the 6700-level shop area on a 24-hour basis.

SUMMARY OF COSTS

Mine: Black Rock Period: Jan. 1, 1957 to June 30, 1957

Ore mined: 71,442 tons

Mining and development costs per ton:

Drilling and blasting	$1.77
Mucking	.65
Slushing	.62
Tramming	.51
Timbering	.19
Pipe and track	.23
Compressors	.16
Lubrication	.02
General shop	.22
Nipping	.15
Lighting	.05
Sampling ore	.10
Diamond drilling	.35
Equipment rental (trucking ore)	.57
General mine expense	.03
Allocated expense including depreciation, supervision, etc...	2.36
Total	7.98

Generated on 2024-09-22 01:32 GMT / https://hdl.handle.net/2027/osu.32435030643365
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Total mining and development costs:

	Total	Per ton	Distribution, percent
Labor	$238,236	$3.33	41.8
Materials	163,211	2.29	28.6
Other (including depreciation, supervision, etc.)	168,426	2.36	29.6
Total	569,873	7.98	100.0

The prevailing wage rate was $2.11 per hour for miners with time and a half paid for all work in excess of 8 hours a day or 40 hours a week. Mining was on a contract basis. Crosscuts, drifts, and raises were paid on a linear foot of advance, stopes in cubic feet of excavation, and mucking and tramming by the ton.

Total average cost per man-shift of all wage earners at the mine, including incentive bonuses, was $26.75.

U. S. GOVERNMENT PRINTING OFFICE: 1960 O - 534958

Generated on 2024-09-22 01:30 GMT / https://hdl.handle.net/2027/osu.32435030643365
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY